Philadelphia, Pa., 11th: light rain began during the night and ended at 11.15 a. m.; brisk northeasterly and brisk to high northwesterly winds prevailed from 9 a. m. throughout the day; maximum velocity, thirty-six miles per hour. The barometer fell 0.50 during the twenty-four hours ending at 8 p. m., 11th.

Block Island, R. I., 10th: light north to east winds. Order to hoist cautionary northeast signals received. Storm from the northeast began 10.30 p. m., and reached a maximum velocity of thirty miles per hour at 11.55 p. m. 11th: the storm continues; highest wind velocity, seventy miles per hour, occurred 3.30 p. m.; storm ended 7.55 p. m.

Boston, Mass.: the barometer fell rapidly during the night of the 10–11th and on the following day, and strong southeast and east winds increased gradually in velocity, blowing a gale during the afternoon of the 11th and night of the 11–12th; maximum velocity forty-four miles from north; barometer rose on the 12th, with brisk to high westerly winds; maximum velocity forty-four miles.

IV.—When area of low pressure number iii, previously described, was forming in the lower Mississippi valley this disturbance was moving eastward north of Washington Territory. It moved rapidly across the continent to the Lake region, the centre remaining north of the United States, and the rate of movement diminishing as it approached the Lake region. The pressure at the centre increased with the easterly movement and it disappeared on the 11th, apparently uniting with low area number iii off the coast of New England.

V.—On the 12th and 13th an area of low pressure covered the north Pacific coast and northern plateau region, the centre being apparently to the west of the coast line. Severe gales were reported on the 12th from the mouth of the Columbia River, the wind reaching a maximum velocity of seventy miles per hour on the 12th, sixty on the 13th, and forty-four on the afternoon of the 13th, all from the south. This storm caused general rains on the Pacific coast, the precipitation being generally heavy throughout California. It apparently moved over the northern plateau region and thence southeastward, crossing to the eastern slope of the Rocky Mountains, where it was central on the morning of the 15th. It covered the central valleys on the 16th, causing heavy rains in all states east of the Rocky Mountains. The principal centre of disturbance passed northeast towards the upper lake region, where it disappeared, a secondary disturbance forming in the southern portion of the area during the morning of the 17th and developing great energy during the day, moving rapidly northeastward along the middle Atlantic and New England coasts, attended by severe easterly shifting to westerly gales and very heavy rains. The barometer fell to 28.78 at Wood's Holl, Mass., on the morning of the 18th, when the centre was near that station. It was followed by a cold wave and snow throughout the Northern States and as far south as Tennessee and North Carolina, the fall in temperature ranging from 20° to 30° at most stations.

The following are extracts from reports of Signal Service observers:

Hatteras, N. C., 17th: storm began 11 a, m., reached a maximum velocity of forty-two miles from the south at 11.05 a. m.; continued during the remainder of the day, and ended at 3.20 a. m., 18th.

Boston, Mass., 17–18th: brisk to high southerly winds occurred during the night and the day of the 18th, maximum velocity thirty-eight miles west.

Philadelphia, Pa., 17th: a heavy rain storm set in 9.45 last night and rain has fallen steadily all day. The barometer has fallen rapidly and steadily and at midnight read 28.65 actual, a fall of 1.55 inches since noon yesterday. There has been a corresponding rise in temperature, the mean to-day being 15° higher than yesterday; winds variable from light to fresh. Rain ended 6 p. m., but occasional light showers followed during the evening; total rainfall for the day, 2.23 inches. At 12.30 a. m., 18th, wind shifted to northwest, increasing in force to a gale (forty-eight miles) between 3 and 4 a. m., continuing high all day and diminishing in force during the afternoon. The change in wind shortly after midnight corresponded with lowest barometer, 28.65 actual. The rise in the barometer after 1 a. m. was as rapid as had been its fall during the preceding day. The change in barometric pressure is represented by an inverted cone, with depth of 1.5 inches. Rain ended shortly after midnight.

VI.—This storm was central far to the north of Montana on the morning of the 19th, and the reports indicate that it probably developed in the north Pacific. It passed southeastward towards Lake Superior, where it was central on the morning of the 20th, and thence over the upper Saint Lawrence valley to the New England coast. It was followed quickly by an area of high pressure, which caused strong northerly winds and a decided fall of temperature in the west quadrants of this storm when it was central off the New England coast.

VII.—This area of low pressure also appeared north of Montana, and probably it originated to the west of the Pacific coast. It moved eastward to Manitoba, where it was central on the morning of the 22d, while a second disturbance was apparently advancing from the Pacific coast, causing general rains at stations west of the Rocky Mountains. An area of high pressure appeared over British Columbia and moved to the southeastward, while another area of high pressure covered the greater portion of the United States east of the Mississippi; between these high areas an extended barometric trough was formed, within which developed areas of low pressure traced as numbers vii and viii. On the afternoon of the 23d the centre of this disturbance was apparently north of Lake Superior, while a secondary disturbance developed in eastern Nebraska. The latter moved northeastward over the upper lake region as a feeble disturbance and disappeared to the northeastward during the 25th.

VIII.—This disturbance is traced on chart i as far to the westward as the central plateau region, but it probably originated to the west of the Pacific coast line. General rains prevailed in California during the 21st and 22d, the rainfall being unusually heavy in southern part of that state. The rains continued in California on the 23d after the centre had passed to the eastward of Nevada. The approach of an area of high pressure from the north apparently forced this disturbance to the southeastward, and it covered central Texas on the morning of the 25th, attended by heavy local rains. At this point the direction of movement changed to the northeast and it crossed the Mississippi Valley near Keokuk, Iowa, followed by a cold wave which extended southward to Texas and over the Lake region and central valleys. General rains occurred in the eastern portion of the United States, and rain and snow in the Lake region and Ohio Valley, while the centre of disturbance passed northeastward over the upper lake region. After leaving the Lake region the disturbance inclined towards the Saint Lawrence Valley and its energy increased with the easterly movement, the minimum pressure, 28.76, occurring on the morning of the 28th at Bird Rocks, Gulf of Saint Lawrence, and strong southwesterly gales were reported in the Maritime Provinces.

NORTH ATLANTIC STORMS FOR DECEMBER, 1888 (pressure in inches and millimetres; wind-force by Beaufort scale).

The paths of the depressions that appeared over the north Atlantic Ocean during December, 1888, are shown on chart i. These paths have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Nine depressions have been traced, of which seven passed eastward from the American continent; one first appeared east of Newfoundland, and one apparently developed over mid-ocean, near the fiftieth parallel. The depressions generally pursued normal east to northeast paths, the exceptions being number 3, which moved east-southeast from Nova Scotia over the Azores; number 7, which advanced somewhat south of east after passing the thirtieth meridian, and number 6, whose path apparently described a loop over mid-ocean. From the 9th to the 13th a depression, which is traced as low area iii, moved from the Gulf of Mexico northeastward off the coast of

the United States to the Gulf of Saint Lawrence, attended from the 10th to the 12th, inclusive, by severe storms. On the 12th the pressure fell below 28.80 (731) over central and eastern Nova Scotia. A notable feature of the month was the storm which moved east-southeast over the Azores during the first decade. The storm-track charts of preceding years show that severe storms are not unusual in that region during the winter months, and that in December, 1887, the passage of depressions over the ocean near the Azores caused abnormally low mean pressure in that locality.

In December, 1887, thirteen depressions were traced, of which seven advanced eastward from Newfoundland or the Grand Banks; one occupied the ocean between the British Isles and Iceland during the 1st and 2d; two originated to the westward of the Azores; two moved northwest from the region east of the Windward Islands, and one was given a probable westward track over the Caribbean Sea. The depressions generally pursued normal east to northeast paths. The month did not present abnormal meteorological features over the Atlantic in the middle and northern latitudes, while over the southern part of the ocean the severe storms of the first decade constituted a noteworthy departure from the usual winter weather in that region.

In December, 1888, the number of depressions traced was one less than the average number traced for December during the past four years. Over the western portion of the ocean the weather continued stormy from the 1st to the 8th, inclusive. From the 11th to the 14th severe storms attended the passage of low area iii; from the 17th to the 19th gales prevailed off the coast of the United States with the passage of low area v, and during the 22d and 28th gales of moderate strength were occasioned by depressions which passed eastward over Newfoundland. Over mid-ocean stormy weather was almost continuous during the month, the severest disturbances being encountered on the 4th, 9th, 18th, and 20th, when the barometric pressure fell below 29.00 (737). Over the eastern part of the ocean the principal storm periods extended from the 1st to the 7th, and from the 19th to the 27th, the severest storms occurring on the 21st and 22d, when the barometric pressure fell below 29.00 (737) over portions of the British Isles.

The following are brief descriptions of the depressions traced:

1.—This depression was central on the morning of the 1st over Newfoundland, whence it moved rapidly north of east and disappeared north of the British Isles after the 3d, attended throughout by moderate to fresh gales.

2.—This depression appeared northeast of the Banks of Newfoundland on the 3d, and by the 7th had advanced to the British Isles, its passage being attended by strong to whole gales; from the 3d to the 5th, inclusive, barometric pressure falling below 29.00 (737) was reported near its centre.

3.—This depression advanced from Nova Scotia, where it was central on the afternoon of the 4th, to the eastward of the Azores by the 7th, after which date the position of its centre cannot be determined. The storm, while possessing fair energy, was remarkable chiefly on account of the path it pursued.

4.—This depression was a continuation of low area i, and advanced from southwest of Nova Scotia, where it was central on the morning of the 6th, to mid-ocean in about latitude N. 55°, where it disappeared after the 10th. This depression exhibited great energy from the 7th to the 9th, inclusive, and during the 8th and 9th had barometric pressure falling below 29.00 (737).

5.—This depression was apparently a subsidiary development to number 4, and is located in about latitude N. 50°, longitude W. 30°, under date of the 11th, when strong to whole gales prevailed over mid-ocean. From this position the storm probably passed eastward, reports will not, however, admit of locating its centre after the 11th.

6.—This depression passed eastward from the south Atlantic coast of the United States during the 13th, and moved northeastward to mid-ocean by the 16th, where it pursued an irregular course until the 19th, after which it apparently recurved to the west or southwest and united with number 7. The depression augmented in energy while central over mid-ocean, where it occasioned fresh to whole gales. On the 16th the barometer readings were high over the British Isles and adjacent waters, after which there was a gradual diminution in pressure in that region.

7.—This depression was a continuation of low area v, and advanced rapidly eastward from Newfoundland, where it was central on the night of the 18th, to the British Isles by the 21st, attended throughout by storms of marked violence and very low barometric pressure. Subsequent to the 21st the weather continued stormy over and near the British Isles, which conditions were doubtless largely due to the presence of this depression in that region.

8.—This depression was a continuation of low area vi, and passing rapidly east-northeast from Newfoundland during the 22d, disappeared northwest of the British Isles after the 23d, attended throughout by gales of considerable strength.

9.—This depression was a continuation of low area viii, and advanced from the Gulf of Saint Lawrence where it was central on the 28th, northeastward to the fifty-fifth parallel by the 29th, after which it disappeared north of the region of observation without evidence of marked energy.

OCEAN ICE IN DECEMBER.

No Arctic ice was reported during the month. In December, 1887, a small berg was observed in N. 46° 10′, W. 47° 28′, on the 26th, and a small berg in N. 48° 20′, W. 48° 40′, on the 28th. In December, 1886, no icebergs were reported. In December, 1885, several bergs were observed off the Newfoundland coast during the latter part of the month. For December of 1882, 1883, and 1884 no icebergs were reported.

FOG IN DECEMBER.

The following are limits of fog-areas on the north Atlantic Ocean during December, 1888, as reported by shipmasters:

Date.	Entered.		Cleared.		Date.	Entered.		Cleared.	
	Lat. N.	Lon. W.	Lat. N.	Lon. W.		Lat. N.	Lon. W.	Lat. N.	Lon. W.
	° ′	° ′	° ′	° ′		° ′	° ′	° ′	° ′
1-2	48 42	46 57	48 39	47 52	27	39 34	73 56	39 36	73 55
7	44 50	49 10	46 02	46 04	27	43 32	59 34	43 16	60 36
12	45 30	49 19	47 26	49 38	27	40 48	69 22	40 35	70 10
12	44 00	55 38	43 57	55 47	27	37 45	75 15	37 30	75 25
12	43 00	63 00	43 20	64 20	27	46 48	47 03	46 40	47 30
17	39 40	73 55	40 15	73 35	27	44 59	52 33	44 36	53 46
18	45 30	58 20	45 05	59 45	28	46 41	48 10	45 50	51 20
19	46 19	46 54	46 14	47 17	28	43 24	57 42	42 52	59 24
22	46 15	48 45	45 41	43 02	28	46 10	48 39	45 50	49 00
22	45 19	53 19	45 06	54 06	28	42 29	61 26	42 45	64 30
26	46 43	46 55	46 23	48 07	28	38 49	73 30	39 01	73 32

The limits of fog-belts to the westward of the fortieth meridian are shown on chart i by dotted shading. In the vicinity of the Banks of Newfoundland fog was reported on nine days, as compared with six days for November, 1888, and fifteen days for December, 1887. Between the fifty-fifth and sixty-fifth meridians fog was reported for a total of four days, as compared with seven days in November, 1888, and three days for December, 1887. To the westward of the sixty-fifth meridian fog was reported on three days, as compared with seven days for November, 1888, and two days for December, 1887. From the above it will be seen that when compared with December, 1887, there was a marked deficiency in the fog banks reported over, or near, the Grand Banks, while over the ocean to the westward slight changes in the aggregate number of foggy days are shown. As compared with November, 1888, there was an increase in the number of fog-areas reported near Newfoundland, while to the westward of that region they were less frequently encountered than in the preceding month. The southern limits were somewhat more extended in November than in the current month.

On the several days for which fog was reported near Newfoundland the passage or approach of an area of low pressure from the westward was shown, except on the 26th and 27th,

when relatively high barometric pressure and variable winds prevailed in that locality. In instances areas of low pressure passed eastward from the American continent attending whose advance no fog has been reported. Between the fifty-fifth and sixty-fifth meridians the development of fog attended the presence to the northward or northwestward of areas of low pressure. Off the coast of the United States fog attended the passage of an area of low pressure over the valley and Gulf of Saint Lawrence on the 27th and 28th; on the 17th a storm of great violence passed northeastward over the middle Atlantic states and a dense fog was reported off the coast south of Sandy Hook.

TEMPERATURE OF THE AIR (expressed in degrees, Fahrenheit).

The distribution of mean temperature over the United States and Canada for December, 1888, is exhibited on chart ii by dotted isotherms. In the table of miscellaneous meteorological data the monthly mean temperatures and the departures from the normal are given for stations of the Signal Service. The figures opposite the names of the geographical districts in the columns for mean temperature show the averages for the several districts. The normal for any district may be found by adding the departure to the current mean when the departure is below the normal and subtracting when above.

The mean temperature was highest over southern Florida, where a reading of 67°.1 was noted at Key West. Values rising above 55° were reported over Florida, south of the thirtieth parallel, along the coast of Texas, in the lower Rio Grande valley, along the south coast of California, in the extreme southwestern part of Arizona, and at stations near the west-central coast of California. The lowest mean temperature occurred in Manitoba, where it ranged to 12° at Fort Garry. Values falling below 20° were reported over northern New Brunswick, in the lower Saint Lawrence valley, northern Ontario, northern Minnesota and Dakota, and northeastern Montana. The mean temperature also ranged below 20° at stations in southwestern Wyoming, northwestern Colorado, and the extreme northeastern part of Utah.

The mean temperature was above the normal over a greater portion of the country, the greatest departures above the normal being noted in Montana and Dakota, where, at stations, they amounted to more than 15°. From this region they become gradually less marked eastward to the Canadian Maritime Provinces, southward to the Rio Grande Valley and the Gulf of Mexico, and westward to the Pacific coast. The mean temperature was slightly below the normal within an area extending from southeastern Arizona and southwestern New Mexico northwestward to north-central California, while to the southward of a line traced from the coast of Virginia southwestward to the Gulf coast between New Orleans, La., and Galveston, Tex., the departures below the normal gradually increased southward to the southern extremity of Florida, where they amounted to more than 4°.

The following are some of the most marked departures from the normal at the older established Signal Service stations:

Above normal.	°	Below normal.	°
Poplar River, Mont	16.2	Key West, Fla	4.2
Fort Totten, Dak	15.4	Jacksonville, Fla	3.4
Minnedosa, N. W. T	12.3	Savannah, Ga	3.3
Moorhead, Minn	12.2	Wilmington, N. C	2.2
Bismarck, Dak	10.2	Keeler, Cal	2.2

MAXIMUM AND MINIMUM TEMPERATURES.

The highest temperatures for the month were reported in the lower Rio Grande valley, where they rose above 80°. Values above 75° were noted over the southern half of Florida, at several points in Texas south of the thirtieth parallel, at Yuma, Ariz., and Los Angeles, Cal. At Des Moines, Iowa, Saint Paul, Minn., Yankton, Dak., Boisé City, Idaho, and Roseburgh, Oreg., the maximum temperatures were higher than for any preceding December during the periods of observation. The most notable deficiencies occurred in the middle Atlantic, south Atlantic, and west Gulf states, in the Ohio and upper Mississippi valleys, the upper lake region, the southern plateau and southeastern slope of the Rocky Mountains, where, at stations, the maximum temperatures were 10°, or more, below the maximum values for the corresponding month of previous years.

The lowest temperatures were reported in northwestern Minnesota, central Montana, southern Wyoming, and northeastern Utah, where they fell below —10°, the lowest reading, —16°, being noted at Saint Vincent, Minn. The minimum temperatures fell below zero in northern New England and northern New York, and north of a line traced from northeastern Minnesota southwestward into Colorado, and thence irregularly northwestward to western Montana. They were below 32°, except in Florida south of the twenty-eighth parallel, along and near the west Gulf coast, in western California, and along the immediate north Pacific coast. Unusually low temperatures have not been reported, and at a large majority of stations they were considerably above the lowest readings previously noted for December, notably in the upper Mississippi and upper Missouri valleys, the upper Lake region, and the middle-eastern slope and the plateau regions of the Rocky Mountains, where, at stations, the minimum readings were more than 30° above the December records of previous years.

RANGES OF TEMPERATURE.

The monthly and the greatest and least daily ranges of temperature at Signal Service stations are given in the table of miscellaneous meteorological data. The greatest monthly ranges occurred over southwestern Dakota, northeastern Montana, and the intermediate territory, where they exceeded 70°. From this region the ranges gradually decreased westward to the Pacific coast, where they amounted to less than 20° at the mouth of the Columbia River, southward to the Gulf coast, where they were less than 35° near Galveston, Tex., and eastward to Michigan, where they were less than 35° along the east coast of Lake Michigan. From this locality they increased to more than 55° over northern New England, from whence they decreased somewhat irregularly to southern Florida, where a range of less than 30° was noted at Key West. Along the Pacific coast the monthly ranges varied from less than 20° over the southwestern part of Washington Territory, to more than 35° in the vicinity of Los Angeles, Cal.

The following are some of the extreme monthly ranges:

Greatest.	°	Least.	°
Poplar River, Mont	72.8	Fort Canby, Wash	19.0
Fort Sully, Dak	72.5	San Francisco, Cal	21.6
Rapid City, Dak	72.4	Red Bluff, Cal	25.6
Northfield, Vt	59.5	Key West, Fla	27.2
Manchester, N. H	57.0	San Diego, Cal	29.0
Rio Grande City, Tex	51.2	Grand Haven, Mich	33.4

DEVIATIONS FROM NORMAL TEMPERATURES.

The following table shows for certain stations, as reported by voluntary observers, (1) the normal temperature for a series of years; (2) the length of record during which the observations have been taken, and from which the normal has been computed; (3) the mean temperature for December, 1888; (4) the departure of the current month from the normal; (5) and